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Gender and achievement in mathematical problem solving and attributions for mathematical achievement in grade three students.

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GENDER AND ACHIEVEMENT IN MATHEMATICAL PROBLEM SOLVING AND ATTRIBUTIONS FOR MATHEMATICAL ACHIEVEMENT IN GRADE THREE STUDENTS

By

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ABSTRACT

This causal comparative study was designed to investigate students' mathematical problem solving achievement and attributions for success and failure in mathematics by gender. Sixty-two third grade students completed a mathematics problem solving test. There were no significant differences in mathematical problem solving achievement by gender. The students' perceptions of the causes of their performance in mathematics were measured using the Mathematics Attribution Scale (MAS). The students rated the strength of each attribute as an explanation for failure and success events. There were no significant differences for failure events by gender. A statistical significance between gender and attributions for success was discovered. Males attributed their success in mathematics to ability significantly more than females.

DEDICATION

This thesis is dedicated to my husband, Jim, who provided unwavering support and encouragement throughout the duration of my studies, and to my professor Dr. Erika Kuendiger for introducing me to the topic of attribution theory and mathematics. She truly inspired me to explore such an intriguing area of study.

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INTRODUCTION

A. General Statement of the Problem

Gender differences and achievement in mathematics has long been a source of concern among educational and mathematical researchers. Women have been considered underachievers in the area of mathematics and are underrepresented within mathematical based professions (Clewell, Anderson, & Thorpe, 1992). Considering that women make up roughly half of the population, this imbalance concerns both the business sector as well as the educational field.

Ontario's new mathematics curriculum, introduced in 1997, focuses heavily on the areas of problem solving skills. Students are expected to engage in mathematical problem solving, beginning in the first grade. The expectations related to students' problem solving skills are more stringent than in the past. Recent studies have shown discrepancies between male students' and female students' achievement in problem solving. Results have varied according to the grade level of the students and the research design. With the new direction in mathematics instruction to include more of an emphasis on problem solving, an understanding of if, and when, gender differences develop takes an immediate importance. One purpose of this study is to examine achievement in problem solving in Grade 3 students and to determine if gender related differences exist.

A common finding among researchers is higher achievement by males in secondary and post secondary school mathematics. Various reasons for these gender differences have been proposed. A common belief is that mathematics is a predominantly male domain, and children have been socialized to adhere to this notion. Parents, educators, and peers play an instrumental role in the formation of children's perceptions and beliefs. The belief system held by children influence their immediate and future actions.

Children's beliefs influence their behaviours, and more specifically their academic achievement in mathematics. Measuring the attitudes and beliefs surrounding mathematics has been performed by researchers for decades. The bulk of the research has focused on the casual attributions of performance in mathematics by males and females in the upper elementary and secondary school grades. This may be a reaction to discrepancies found in mathematical achievement at these levels. It is apparent that there is little research in the area of attributional causes of mathematical achievement in the early elementary grades. The second purpose of this study is to examine attributions for mathematical problem solving achievement in Grade 3 students and to determine if gender related differences exist.

B. Definition of Terms

For the purpose of clarity the following terms are defined:

Attributions: personal explanations of causality. According to Weiner (1976), attributions fall into one of four categories; ability, effort, task difficulty, or luck. These elements can be categorized by their level of stability, internality, and control. If a child perceives an outcome to be due to ability level or difficulty of the task, then the perception can be categorized as stable. Outcomes attributed to effort and luck are categorized as unstable. Causes that originate from within the individual, such as ability and effort are categorized separately from external causes, such as task difficulty or mood of the teacher. The control category differentiates between causes such as effort, which is within the power of the individual, and ability, which is not controllable.

Word Problems: mathematical questions in which the operations are not explicitly stated, and the student must determine which operation to perform, as well as which pieces of information in the problem to use

C. Review of Literature

Gender and Overall Mathematical Achievement

Since the 1950s, gender differences in mathematics performance have been a major topic in educational and mathematical research. Research conducted in the late 1950s and 1960s found that boys generally showed stronger numerical and spatial abilities and performed better on tests of mathematical reasoning than girls, but girls usually did better in verbal and linguistic studies (Anastasi, 1958; Maccoby, 1966; Tyler, 1956, 1969). These findings were reinforced by Maccoby and Jacklin (1974) a decade later.

Researchers have found that during elementary and junior high years, girls generally do as well as boys on standardized tests of math achievement (Fennema, 1974; Sherman, 1980). Several studies are in agreement that although in the grade school years girls equal boys in mathematical achievement, and surpass them in verbal achievement, during the junior high and high school years, boys pull ahead and remain ahead in mathematical achievement (Donlon, Ekstrom & Lockheed, 1976; Fennema & Sherman, 1977; Hilton & Berglund, 1974, Maccoby & Jacklin, 1974).

Recent meta-analytic reviews of the gender differences literature in mathematics by Hyde (1981), Feingold (1988), and Marsh (1989) show that the differences are small and declining. Ethington (1990), in an analysis of Grades 7 and 8 mathematics data from eight countries, concluded that there were no gender effects and, further, that what effects were discernable were in favour of girls. Meece and Jones (1996) have also stated that over the past two decades there has been a decline in the gender gap in the field of mathematics. The researchers noted that there were still significant differences between the genders by the end of high school.

A study conducted by Porter (1999) was designed to determine if there was a gender difference in students' mathematics performance as determined by the Iowa Test of Basic Skills and by the Tests of Achievement and Proficiency in a school system in Southwest Georgia. The students ranged from first graders to tenth graders. An analysis of variance found a significant difference in the total mathematics achievement scores between genders in favour of the female students. Additional analysis revealed statistically significant differences in mathematics performance favouring females over males in the first grade and in the fourth grade. In all grades, except the second grade, the females' scores were higher than the males'.

The Education Quality and Accountability Office (EQAO) test, has been used across the province to assess language and mathematics skills of children from Ontario for the past four years. The children's responses were marked according to levels. The levels ranged from one to four. Level three indicated that the child has achieved provincial standard, while level four indicated an achievement exceeding the provincial standard. In 2001, at both the Grade 3 and 6 levels, a higher percentage of girls than boys achieved levels three and four. In Grade 3, 62% of girls achieved at or above level three in mathematics, while 60% of boys achieved at the same levels. In Grade 6, 56% of girls achieved at or above level three in mathematics, while only 53% of boys achieved at the same levels. This gap has remained constant since the province-wide testing began in 1997-1998 (EQAO Ontario Provincial Report on Achievement, 2001).

<u>Gender and Achievement in Mathematical Problem Solving</u>

For decades researchers have examined the relationship between gender and overall mathematical achievement. Many researchers have realized the importance of separating mathematical skills into smaller concepts and have chosen to narrow their focus of study. One area of particular interest has been the concept of reasoning and problem solving. According to Stanley and Benbow (1986) mathematical talent was best defined as the ability to cope with lengthy chains of reasoning. The researchers also believed that mathematical reasoning ability is important for high-level achievement in mathematics and the sciences.

The importance of problem solving skills and possible gender differences was noticed and attended to early in the 1970's. Maier and Casselman (1971) examined the process of understanding ideas and making essential distinctions in the realm of mathematics. The researchers concluded that whereas males consistently scored higher than females on problem-solving tests, women's best performance was on idea-getting problems rather than on problems that required making essential distinctions.

Research conducted by Robitaille and Sherrill (1979) yielded similar results. The researchers analyzed results from the British Columbia Mathematics Assessment, a large-scale survey in which over 100,000 students in Grades 4, 8 and 12 took part. Results in general indicated that females performed better than males in computation, while males performed better on objectives which required higher order cognitive processing.

Results for the Second National Assessment of Mathematics (Fennema & Carpenter, 1981) for the United States found that females scored higher on the lower level number and numeration skills at ages 9 and 13. At the same age levels, a consistent pattern of lower scores was found for females on geometry and measurement exercises over all cognitive levels.

The purpose of Marshall's (1984) study was to examine girls' and boys' performance on two types of mathematics items: computations and story problems. The Survey of Basic Skills, Grade 6 was administered to all sixth grade children enrolled in California public schools in 1979, and their scores were analyzed. The results indicated differences in sixth grade boys' and girls' responses to computations and story problems. Boys tended to perform better than girls on story problems and girls tended to perform better than boys on computations. Similar results were reported by Fennema (1974). Junior high school girls excelled in computation, while boys excelled on tasks requiring mathematical reasoning.

Marshall and Smith's (1987) longitudinal study examined children's mathematics performance on assessment tests given at third and sixth grades. The test instruments used in the study were the Surveys of Basic Skills for Grades 3 and 6. Rather than rely solely on the number of total correct responses, the researchers focused on analyses of individual items. The test items from the instruments fell into six categories common to both tests: computation problems, counting problems, visual problems, geometry/measurement problems, traditional word problems, and nontraditional word problems. Word problems were traditional story problems containing one or more arithmetic operations. Nontraditional problems were story problems that did not require a computational response. Instead, the student had to identify relevant information or recognize a similar problem. Results showed that third grade girls demonstrated better performance on every category of item except word problems, surpassing the performance of boys on a large number of items in computations, counting, geometry/measurement, and nontraditional problems. At the sixth grade, girls continued to surpass boys on computations, but boys had a clear advantage in solving word problems and geometry/measurement items. Counting and visual problems were roughly equal in difficulty for boys and girls.

The strong performance by girls in relation to boys at the third grade declined by the time they were evaluated in the sixth grade. The girls had lost ground in two areas of strength- counting and nontraditional items- and had fallen behind to a great extent in word problems and geometry/measurement items.

A 1990 meta-analysis of 100 studies surrounding gender differences in mathematics performance was conducted by Hyde, Fennema and Lamon. The purpose of the study was to make a refined assessment of the magnitude of gender differences in mathematics performance. The ages of the subjects were divided into five subgroups: 5- to 10- year olds, 11- to 14- year olds, 15- 18- year olds, 19- to 25- year olds, and those 26 and older. The results indicated that females were superior in computation in the elementary and middle school years. Problem solving presented a different picture. There was a slight female superiority or no gender difference in the elementary and middle school groups. A moderate gender difference favoring males was found in the high school and college groups. Several other studies have suggested that gender differences in mathematical problem solving are not generally seen until later in high school (Feingold, 1988; Fennema & Carpenter, 1981; Leder, 1992; Weiner & Robinson, 1986).

Lummis and Stevenson's (1990) study evaluated cross-cultural differences in gender differences in mathematical performance. The subjects were children in kindergarten and Grades 1 and 5 in schools in Taiwan, Japan and the United States. The researchers developed their own achievement tests which were based on their analyses of the content of the children's textbooks. Results showed that girls performed as well as boys in computational problems involving the basic operations of mathematics. Boys, as early as the first grade, were better able than girls to solve word problems, problems involving visual estimation of quantity and distance, and problems requiring the visualization of various transformations of geometrical forms. The findings were similar among the three cultures.

Mills, Ablard and Stumpf's (1993) study examined the issue of gender and mathematical reasoning ability. They sought to find out if boys and girls differed in mathematical reasoning ability and, if so, was there a difference according to age or grade level? Their study consisted of academically talented students in Grades 2 to 6. Although all students were considered academically talented, not all were talented specifically in mathematics. The School and College Ability Test Series III was used in the study. Analysis of the data revealed that boys performed better than girls across all grade levels, and that performance increased with grade level for both boys and girls. Even among the youngest students, the second graders, the scores of the boys were higher than those for girls, as documented by means that differ by more than one third of a standard deviation. This finding suggests that gender differences in mathematics ability, at least in a population of highly able students, appear much earlier than thought and are relatively consistent across age levels. The researchers' findings are consistent with previous studies conducted on the topic of formal operational thinking. Ablard, Tissot and Mills (1992), as well as Keating (1975) have conducted studies that have found that academically talented students exhibit performance indicative of formal operations well before twelve years of age.

The use of different solution strategies on math problems by high school students of high mathematical ability were examined by Gallagher and De Lisi (1994). The study examined whether there was a gender difference in the use of strategies on math problems. Interviews were conducted while the students solved questions from Scholastic Aptitude Test (SAT-M), to determine the strategy utilized to answer the problems. The problems were classified into two basic categories that were based on strategies that could potentially be used to solve them. Conventional problems were those that could be answered only by primarily algorithmic methods. The method of solution was clearly defined. Unconventional problems were those that either required the use of an atypical solution strategy, or could be solved using some type of estimation or insight.

Male and female students did not differ in overall performance on the problems. Separate scores were derived for performance on conventional and unconventional problems. Female students averaged 75% correct on conventional problems and 68% correct on unconventional problems. Male students averaged 69% and 79% correct on these respective types of problems (Gallagher & De Lisi, 1994). Studies conducted by Armstrong (1985) and Dossey, Mullis, Lindquist and Chambers (1988) have also found that male students often do better on problems that are not well defined and which require less standard types of solution strategies. This characterization covers many word problems and geometry problems.

Gallagher and De Lisi's (1994) analysis of the interviews indicated that female students relied more heavily than did male students on conventional strategies that are generally taught in the classroom, whereas male students were more apt than female students to use unconventional problems. The researchers suggested that gender differences for high ability students are due, at least in part, to differences in solution strategies.

The purpose of Carr and Jessup's (1997) study was to address questions about the roles of metacognitive and social influences on the development of gender differences in mathematics strategies. Fifty-eight first grade children participated in the study. The children were interviewed individually and within a group setting at three time points throughout the year. The children were asked to solve 10 addition and 10 subtraction problems. Following problem solution, the children were asked to explain how they solved each problem. No gender differences in total correct responses emerged. Differences did emerge in the types of strategies utilized by the children. Girls were more likely to use overt strategies, such as counting on fingers or using counters; boys were more likely to use covert strategies, such as retrieval from memory.

A study conducted in Newfoundland, Canada by Duffy and Gunther (1997) looked at gender differences in the mathematical problem-solving performance of 12-year-olds using tests of mathematical problem solving. One hundred and fifty nine students were administered the Canadian Test of Basic Skills (CTBS) and the GAUSS at the beginning and at again at the end of the school year. The problem-solving scale in the CTBS is entirely composed of mathematical word problems. The GAUSS is a test of nonroutine mathematical problems. It included computational problems as well as word problems. The GAUSS was rated by experts as the more difficult and more abstract of the two tests.

The study found that males outnumbered females among the top performing students on the CTBS, but there was no gender difference found on the GAUSS. Based on this finding, the researchers suggested that gender differences in mathematical problem solving, at least with 12-year-olds, is not an ability difference, but instead that there might have been aspects of the tests themselves that interacted with prior socialization differences to produce gender differences in performance.

Research conducted prior to Gallagher and De Lisi's (1994) study have found similar results. A series of reports (Benbow, 1988, 1992; Benbow & Stanley, 1980) have focused on the top performing seventh and eighth graders on the mathematics section of the Scholastic Aptitude Test (SAT-M). These studies consistently found that males performed better than females on mathematical problem solving.

A longitudinal study conducted by Fennema, Carpenter, Jacobs, Franke, and Levi (1998) investigated gender differences in problem solving and computational strategies used by boys and girls as they progressed from Grades 1 to 3. Each student was interviewed individually. The students were asked to answer several types of mathematical problems and to explain the strategies used to solve them. The mathematical problems included number facts, addition and subtraction problems, nonroutine problems which involved multiple steps and required interpretation and analysis, and extension problems which were problems that potentially assessed children's understanding of number concepts as reflected in their ability to operate flexibly with large numbers. The researchers found no gender differences in solving number facts, addition or subtraction problems, or nonroutine problems throughout the three years of the study. Gender differences were found in the strategies used to solve problems, with girls tending to use more concrete strategies and boys tending to use more abstract strategies that reflected conceptual understanding. On the problems that required flexibility in extending one's procedures, boys were more successful than were girls. The researchers suggested that the ability to solve extension problems in the third grade appeared to be related to the use of abstract strategies used more often by boys.

Theoretical Frameworks

Theorists have proposed that gender differences in test performance and choices are caused in part by gender differences in achievement-related beliefs. Attribution theorists (Eccles et al., 1983; Frieze, Fisher, Hanusa, McHugh, & Valle, 1978; Weiner et al., 1971) argue that people's causal expectations for successes and failure affect their self-concept of ability, future expectations, and subsequent achievement behaviours. According to Weiner (1974), attributions fall into one of four categories; ability, effort, task difficulty, or luck. These elements can be categorized by their level of stability, internality, and control. If a child perceives an outcome to be due to ability level or difficulty of the task, then the perception can be categorized as stable. Outcomes attributed to effort and luck are categorized as unstable. Causes that originate from within the individual, such as ability and effort are categorized separately from external causes, such as task difficulty or mood of the teacher. The control category differentiates between causes such as effort, which is within the power of the individual, and ability, which is not controllable.

The importance of causal attribution theory to achievement lies in its demonstrated relationship to expectancy for success (Weiner, 1974). If an outcome is attributed to a stable factor, the same outcome will be expected in the future. If, however, the outcome is attributed to an unstable factor and there is sufficient doubt as to whether a prior success will be repeated, behaviour directed toward the achievement of that outcome is not likely to persist (Weiner, 1974). Weiner has also shown that some emotional responses to achievement outcomes are linked to particular attributions. For example, pride and shame are associated with perceptions of internal causes and not with perceptions of external causes (Weiner, 1986).

Weiner's more recent work (1994) developed further the effort/ability dimension in personal motivation. He argued that a constant occurrence in education is that students who are low in ability and try hard are very highly evaluated, particularly when they succeed. Conversely, those high in ability who do not try are appraised most negatively, especially when they fail. Weiner argued that failure perceived by the student as caused by lack of ability results in performance decrements; while failure ascribed to a lack of effort results in performance increments because the student perceives that they can do something about it, like try harder.

Closely related to attribution theory is the work on locus of control and learned helplessness. Dweck (1975) introduced the concept of academic learned helplessness to describe children who assume they cannot control their successes and failures and who give up when confronted with failure. On the other hand, mastery-oriented children show increased persistence or improved performance when failure is experienced (Dweck, 1975; Dweck & Goetz, 1977; Dweck & Reppucci, 1973). Dweck suggested that mastery-oriented children are more likely to attribute failure to lack of effort, a cause perceived as under one's control. Learned helplessness children, on the other hand, are more likely to blame their failure on uncontrollable external factors; and when they do take responsibility, they are more likely to attribute failure to a lack of ability, an uncontrollable internal factor.

More recently, Dweck and Licht (1980) have extended this work to the domain of math, suggesting that the sex difference in the occurrence of learned helplessness behaviour may be responsible for sex differences in mathematics achievement behaviours. Research results surrounding gender and learned helplessness are inconsistent. Earlier studies conducted by Dweck, Davidson, Nelson, and Enna (1978), and Nicholls (1980) have reported females as being less intrinsically motivated than males and exhibit learned helplessness, both of which have implications for female achievement. More recent research conducted by Ryckman and Peckham (1987) reported similar results. They found that girls had a more learned helplessness orientation in math/science domains than did boys. In contrast, the findings of Kaczala, Parsons, Futterman and Meece (1979) and Parsons, Meece, Adler and Kaczala (1982) have shown little support for the hypothesis that girls are more learned helpless in mathematics than are boys. In a 1980 study conducted by Parsons, 90% of the children classified as learned helplessness were boys.

Social cognitive theory suggests that self-efficacy, "people's judgements of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391), strongly influences the choices people make, the effort they expend, and how long they persevere in the face of challenge. Bandura (1986) argued that self-efficacy and self-concept represent different phenomena and must not be mistaken for each other. Self- efficacy is a context-specific assessment of competence to perform a specific task. Self-concept is not measured at that level of specificity and includes beliefs of self-worth associated with one's perceived competence. Bandura (1986) stated that beliefs regarding confidence are part of an individual's self-concept.

The topic of confidence in mathematics and gender has been explored by researchers and produced varying results. Several researchers have found that females have less confidence in their mathematical ability than do males, even though mathematical achievement in the classroom is consistently higher among females than males (Fennema & Sherman, 1977, 1978; Parsons, 1983; Parsons, Kaczala, & Meece, 1982; Pedro, Wolleat, Fennema, & Becker, 1981; Reyes, 1984; Robitaille, 1977; Sherman, 1980). Similar results were found when students across Ontario took part in a standardized test administered by the Education Quality and Accountability Office (EQAO). Although girls outperformed boys in math, when asked to indicate whether they were good at mathematics, the boys' attitudes appeared to more positive than those of girls (EQAO Ontario Provincial Report on Achievement, 2001). The findings of researchers, Pintrich and De Groot (1990) suggested that boys and girls report equal confidence in their mathematical ability during the elementary years, but by middle and high school, boys had grown more confident.

A survey on attitudes toward mathematics of third and fifth grade students was conducted by Vanayan, White, Yuen and Teper (1997). The survey that was used was adapted from an Ontario Ministry of Education survey entitled Student Questionnaire Mathematics, part of the 1988-1989 provincial reviews of mathematics and reading for Grade 6. In Grade 3 and 5, more boys than girls indicated that they were proficient at mathematics. Although a relatively low percentage of girls and boys indicated that mathematics was hard for them, this percentage dropped for boys from 14% in Grade 3 to 9% in Grade 5, but remained constant at about 12% in both years for girls.

Studies on Mathematics, Attributions and Gender

Secondary School

The purposes of Wolleat, Pedro, Becker and Fennema's (1980) study were to test casual attribution theory in the domain of mathematics and to examine the effects of level of mathematics achievement, sex and the interaction of level of achievement and sex on attributional patterns. The study included 647 female and 577 male secondary students. The subjects completed the Mathematics Attribution Scale, an instrument used to measure high school students' perceptions of the causes of their performance in algebra and geometry. The subjects also completed an achievement test to measure their performance in algebra and geometry. Significant differences between females and males were noted, indicating that attributional patterns existed. Females more strongly than males used effort (unstable) to explain their success. When explaining mathematics failure, females invoked more strongly than did males the attributions of ability and task difficulty (both stable). These differences were in the direction predicted from general attribution theory. Similar findings were reported several years later by researchers Ryckman and Peckham (1987) and Stipek and Gralinski (1991).

Intermediate and Junior Grades

Parsons, Meece et at. (1982) investigated the hypothesis that girls are more likely to be learned helpless in math than boys. Three hundred and thirty students from fifth to eleventh grade were given a questionnaire which included, among other measures, four attributional measures and questions assessing their expectations for their performance in both current and future math courses and their self-concept of mathematical ability. The children's attributions for success and failure on a math test were assessed using two open-ended attributional questions as well as two close-ended attributional questions. The close-ended questions were essentially rank-order questions, where the students had to select the most important cause of success or failure from a list of attributions. The list of attributions consisted of: ability, teacher help, parent help, interest, consistent effort, immediate effort, task difficulty, and mood or unstable internal state at time of test.

The researchers concluded that the overall pattern of sex differences and attributions depended on the methodology used. In response to the open-ended questions, girls were more likely than boys to attribute both their successes and failures to skill, while the boys were more likely than girls to attribute both their successes and failures to effort. Skill and immediate effort were the most preferred attributions of both boys and girls. Ability was rarely mentioned by either sex. The data suggested that both sexes see success and failure experiences as largely within their control. The ranked data showed significant sex differences for only two of the eight reasons the children were asked to rank. Boys ranked ability as a more important cause of success than did girls, while girls ranked consistent effort as a more important cause of success than did boys. The reverse pattern emerged for failure (Parsons, Meece et al., 1982).

Both sexes weighed the importance of effort and skill acquisition as quite high relative to other possible causal attributions, and neither sex saw math success primarily as a consequence of ability. The researchers concluded that there was little support for the hypothesis that girls are more learned helpless than boys in mathematics. Prior studies conducted by Kaczala et al. (1979) and Parsons (1980) support this finding.

Sex differences in children's attributions for success and failure on math and spelling tests was examined by Stipek in 1984. A group of 165 fifth and sixth graders were given questionnaires before and after regularly scheduled math and spelling tests. Pretest questionnaires measured students' self-perceptions of competence in the subject and their performance expectations on the test. Questionnaires given after the corrected tests were returned, assessed students' actual performance, subjective ratings of success, attributions for the cause of their success or failure, and performance expectations for future tests.

Results indicated that sex differences existed in math but not in spelling. Girls were more likely to attribute failure on the math test to lack of ability and less likely to attribute success to ability than were boys (Stipek, 1984). This finding has been supported by many other researchers (Eccles et al., 1983; Licht & Dweck, 1984; Parsons, 1983; Parsons, Meece et al., 1982; Pedro et al., 1981; Ryckman & Peckham, 1987; Stipek & Gralinski, 1991; Tapasak, 1990; Wolleat et al., 1980). Within Stipek's study (1984), it is important to note that the actual scores of boys and girls in the failure group were not significantly different, and the success groups were roughly equivalent.

Not all research has supported the findings of Stipek (1984). Cooper, Burger and Good (1981) examined the locus of control beliefs for young males and females. Elementary school children ranging from grades three to five were included in the study. Results indicated that females cited effort as the cause of success in mathematics more often than males, but found no gender differences in effort attributions for failure. Seegers and Boekaert's (1996) study examined the belief systems of eighth grade students. Their data revealed that girls attributed failure in mathematics more often than boys to lack of ability, but attributing success to effort did not differ significantly between boys and girls.

Tapasak (1990) studied differences in individuals' perceptions of themselves and their performance in mathematical achievement situations. Tapasak developed an Expectancy-Attribution (E-A) process model based on Weiner's work, with an emphasis on the stability component (Weiner, 1974). Within the stability dimension, outcomes may be attributed to stable causes (e.g., ability, task difficulty) or to unstable causes (e.g., effort, luck). Within the E-A model, positive and negative patterns were proposed. The positive pattern was hypothesized to be characteristic of individuals who maintain high expectancies for future performance. They attribute successful performances to stable factors and explain failures as being determined by variable factors. The negative pattern was hypothesized to be characteristic of individuals who maintain low expectations for future performance. They attribute successful performances to variable factors and explain failures as being determined by stable factors.

The intent of the study was to discover whether the proposed cognitive patterns would differentiate between male and female students. Two hundred and thirty-nine eighth grade mathematics students participated in the study. The students were asked to complete the Mathematics Attribution Scale (MAS) (Fennema, Wolleat, & Pedro, 1979) to provide information about attributions for their math performance. The students also provided information about their relative performance expectancies for the following grade level, by completing a rating scale of relative math expectancy (RME). The RME was measured using a nine-point scale, in which students were asked to imagine that math classes had students at the bottom, middle and top ranges. The students had to indicate where they felt they would place in their math class, as compared to their classmates (Tapasak, 1990).

Tapasak (1990) reported that expectancy attributions followed a distinct pattern. High RME positively correlated with the positive model of expectancy attribution model, and the Low RME group positively correlated with the negative pattern. A significantly greater percentage of the High RME group was male and a significantly greater percentage of the Low RME group was female. The students also explained their math successes and failures differently. Females felt that their effort, rather than their ability was the main cause of their successes, but viewed their ability as the main cause of their math failures. Tapasak (1990) concluded that many males and females utilized different cognitive styles and interpreted mathematics performance differently, despite the fact that females frequently held higher grade point averages than the male students.

Primary Grades

The purpose of Marsh, Craven and Debus' (1991) study was to examine the abilities of young children to differentiate specific facets of self-concept and to form a generalized conception of self. They also examined age and gender differences in self-concepts for younger children. The researchers sought to test a claim by Harter (1983), that general self-concept does not exist before the age of 8 years. Harter (1983) argued that children's self-concepts are relatively undifferentiated early on and gradually become more differentiated. A total of 501 students from kindergarten, Grade 1 and Grade 2 participated in the study. The Self Description Questionnaire I (SDQ-I), an instrument to measure multiple dimensions of self-concept for preadolescents, was modified for use with the subjects. Approximately 2 weeks after the SDQ-I was administered individually to the students, the SDQ-I was administered to nearly all of the second grade children and a majority of the first grade students within a group administered procedure. Repeated measures of ANOVA were used to assess the effects of age and sex across the scales. There was no significant difference in the self-concept of males and females in mathematics. The crucial result of the study was that general self-concept was reasonably well-defined and reliable for the age range considered in this study. The results revealed that self-concept is much better differentiated by young children than had previously assumed and that these children had a global self-concept. These findings corroborated those of Harter (1982), Harter & Pike (1984), and Marsh, Barnes, Cairns & Tidman (1984), who have shown that children's competence perceptions in different domains are clearly differentiated as early as kindergarten.

Stipek and Gralinski's (1991) study examined gender differences in mathematics achievement-related beliefs and emotions. The researchers sought to reveal at what age gender differences emerge. A sample of 194 third graders and 279 junior high school students completed questionnaires measuring achievement-related beliefs before and after they took a regularly scheduled mathematics exam. Results indicated that both younger and older girls rated their ability lower, expected to do less well, were less likely than boys to attribute success to high ability and failure to luck, and were more likely to attribute failure to low ability. All of the gender differences found in the study appeared by the third grade.

The development and socialization of children's self-perceptions, task values, and activity choices was assessed over three years by researchers, Wigfield et al. (1997). The combined cross-sequential sample provided information on children from Grade 1 through Grade 6, and consisted of approximately 615 children. Each spring, the children completed questionnaires measuring their competence beliefs and subjective task values about math, reading, instrumental music, and sports. Most items were answered using a 7-point Likert-style response scales. Multivariate analyses of variance were used to analyze the data.

Gender differences in children's competence beliefs and subjective task values were found, beginning in Grade 1. Boys had significantly more positive competence beliefs than did girls in the domains of math and sports. In contrast, girls had significantly more positive competence beliefs than boys in reading and instrumental music (Wigfield et al., 1997). Other studies have reported similar differences in early adolescents. Boys hold higher competence beliefs in math and sports than girls do, whereas girls often have higher competence beliefs in the language and social domains (Eccles et al., 1989; Eccles, Wigfield, Harold & Blumenfeld, 1993; Harter, 1982; Marsh, 1989, 1993; Marsh et al., 1991; Wigfield, Eccles, Mac Iver, Reuman & Midgley, 1991). In regards to subjective task values, Wigfield et al. (1997) found that boys and girls did not differ in how much they valued math. This result echoed that of Eccles et al.'s

(1993) study of young children's values.

Wigfield et al. (1997) revealed that children's competence beliefs and subjective values generally declined over the middle childhood years, particularly children's competence beliefs and ratings of the usefulness-importance of different activities. Prior work conducted by Eccles et al. (1993), Parsons and Ruble (1977), and Stipek and Mac Iver (1989) support this depiction that children's achievement-related beliefs become more established during middle childhood, and that many younger children tend to be optimistic in their self-evaluations, and older children more realistic.

A British study was conducted by Gipps and Tunstall (1998) to probe six and seven-year-olds' understanding of success and failure in relation to math, painting, reading, and 'getting on' with work. Forty-nine children of varying abilities were chosen for interview and observation over the course of one school year. The responses given by the children resulted in nine attributional categories. They were: specific competence, general ability, effort, speed, task difficulty, teacher feedback and role, interest/motivation, home and time spent in school. Effort was the most commonly cited reason for success and failure. Specific competence (being good at a particular activity) was the second, and role of the teacher was the third most commonly cited reason(Gipps & Tunstall, 1998). In this study, some of the children were able to make a distinction between ability and difficulty, stating that some of their classmates had higher ability when they were more successful on tasks than other children. This finding was supported by the work of Nicholls and Miller (1983) in their study of young children's development and ability to differentiate between task difficulty and ability.

D. Research Questions and Hypotheses

The purpose of this study is to examine the following questions:

Question 1: Do male and female third grade students achieve at the same level in mathematical problem solving?

Question 2: Do male and female third grade students differ in their attributions for achievement in mathematical problem solving?

The data from this study will be analyzed through the use of the following null hypotheses:

Hypothesis 1: There is no statistically significant difference between males' and females' achievement in mathematical problem solving in Grade 3 students.

Hypothesis 2: There is no statistically significant difference between males' and females' attributions for achievement in mathematical problem solving in Grade 3 students.

E. Significance of the Study

Achievement in mathematics is an area of considerable concern for educators, especially in the presence of national and provincial assessments. With the area of problem solving becoming more pronounced in today's curriculum, it is essential that all students, male and female, be equipped with the skills to solve problems effectively. Teaching styles and instruction methods must be examined to ensure that adequate instruction time is allotted for the explanation and modeling of problem solving strategies. Varying strategies and procedures need to be explored and shared with the students, starting in the early elementary grades. Female students must be made aware of their successful performances in mathematics and their achievements recognized and celebrated. Males and females should be viewed as equals within the realm of mathematical problem solving. This view needs to be shared by educators, parents, as well as the students. Insight into how girls and boys approach mathematics and their preference for different strategies may be an area of further exploration by researchers.

Students' performance in mathematics related activities are clearly connected with their self-perceptions of their mathematical abilities. The attributions held by male and female students in respect to mathematics is an issue to be explored and understood more clearly. The types of feedback offered by teachers to individual students may influence motivation and achievement in the classroom. A greater awareness of educators' own views and beliefs toward gender-related ability and effort must be examined. Educators need to reinforce in students the importance of effort and hard work in their quest for success. Students need to be aware that they are in control of their successes and failures and that they can alter their outcomes if necessary. Females in particular must be reassured that they possess innate mathematical abilities and talents.

Administrators of individual school boards may look at providing attribution training to teachers. They may also wish to implement programs within their schools to encourage greater female participation in mathematics related activities, which in turn may result in greater self-confidence held by female students. Beliefs held by parents about their children's mathematical abilities also influence their children's beliefs about the causes of success and failure in mathematics. Parents need to examine their own beliefs about their children's causes for achievement. Attempts to encourage effort, as well as reaffirm innate abilities within their children are necessary.

CHAPTER II

DESIGN AND METHODOLOGY

A. Subjects

The sample for this study consisted of 62 primary elementary students. This was a convenience sample of subjects from two intact Grade 3 classrooms. The age of the students ranged from 8 to 9 years of age. They attended a middle sized school located in an upper, middle class socioeconomic neighborhood in Southwestern, Ontario. Of the 62 students, 32 students were males and 30 were females. Five percent of the students had been formally identified as having learning difficulties. Non- caucasian students comprised five percent of the sample.

B. Instrumentation

The instrument that was used to measure students' achievement in problem solving was the Achievement in Problem Solving Test (APST), designed by the researcher. The APST contains 40 story problem questions. The operation to be utilized to correctly answer the question is not explicitly stated. The students must determine which operation to perform. The story problems encompass four areas of numeration: addition, subtraction, multiplication, and division. The APST consists of 10 questions from each area of numeration, totaling 40 questions (see Appendix A). Information about the reliability and validity of the APST is unknown at this time.

The instrument used to measure students' perceptions of the causes of their performance in mathematical problem solving and mathematics in general was the Mathematics Attribution Scale (MAS), designed by Fennema, Wolleat & Pedro (1979).

The MAS contains eight subscales. Each subscale describes success and failure events coupled with a statement focused on each of the four attribution categories; task, environment, effort, and ability. Students rated the strength of each attribute as an explanation for the event on a 5-point Likert type scale. The students indicated their degree of agreement with the various statements; strongly agree, agree, undecided, disagree, and strongly disagree.

Scores for the eight attribution subscales are obtained by summing each of the four categories of attribution statements. Subscale scores can range from 4 to 20. There is no meaningful overall score.

The MAS was originally designed to measure high school students' perceptions of the causes of their performance in algebra and geometry. The MAS includes Instructions for Modification which allow the instrument to be used with various study groups. The MAS was modified for use with third grade classes by replacing the word algebra in scale items by the general term mathematics. The statement, You got the grade you wanted for the semester in algebra, was replaced with the statement, You got the grade you wanted in math on your first term report card, to reflect the organization of the elementary school system. The statement, There were times when you were not able to solve the equations, was replaced with the statement, There were times when you just couldn't get the hang of a math lesson, to accommodate for vocabulary differences in younger children.

The organization of the MAS was also modified to reflect the students' perceptions of performance on the Achievement in Problem Solving Test (APST). The

MAS was divided into two sections: Specific to the Achievement in Problem Solving Test and General Achievement in Mathematics. The first section consists of two events directly related to the APST. The second section consists of seven events related to general mathematics achievement (see Appendix B).

Internal consistency reliabilities based on the Cronbach alpha treatment are reported as .77 and .79, respectively, or Success-ability and Success-effort subscales.. For Failure-ability and Failure-effort, reliabilities are .67 and .66, respectively. Reliability coefficients of .39, .48, .48 and .48 were obtained for Success-task, Success-environment, Failure-task and Failure-environment subscales. The authors of the MAS attribute low reliability of these subscales to the variations in the kinds of tasks and environments included in the items. Information about the validity of the MAS is unknown at this time.

C. Design and Procedures

Causal-comparative research attempts to determine the cause for, or consequences of, existing differences in groups of individuals. Causal-comparative studies usually compare two or more groups of subjects and typically involve at least one categorical variable. The groups that are different on a variable are compared on another variable. These studies are good at identifying relationships between variables, but they do not necessarily indicate cause and effect.

A causal-comparative research design was utilized in this study. The variable of gender (categorical variable) was compared with the variable of achievement, and later with the variable of attributions. All variables were free of manipulation, as any differences between the groups had already occurred before the study was conducted.

Permission was obtained from the Faculty of Education, University of Windsor Ethics Committee, and the School Board in question, prior to the commencement of the study (see Appendixes C & D). The principal of the school involved, as well as the Grade 3 teachers, gave consent for the study to take place (see Appendixes E & F). Consent was obtained from the parents of each of the participating students, as well as assent from the students (see Appendixes G, H & I).

The students' mathematics teacher administered the APST to the students during the last half of the second term of the school year. This time was selected as the students had been exposed to the areas of multiplication and division by then. The students completed the test in their own classroom settings during the approximate time of their regularly scheduled mathematics period. The mathematics teacher explained to the students that they could use calculators to help them solve the problems, as computational skills were not being examined, but rather their ability to determine the important information and correct operation. The students were asked to show their work, in the form of numbers and operations utilized to answer the question. The students were told that the results of the test would not have a bearing on their report cards. Those students that required assistance in reading the questions were read the questions by the mathematics teacher. The students were permitted as much time as required to answer the questions. Most students completed the test in an hour and a half.

The tests were collected by the mathematics teacher who recorded the gender of the student as well as a student identification number on each test. The identification numbers were numbers selected by the mathematics teacher to represent each student. The identification numbers were known only to the mathematics teacher. The tests were then given to the researcher for marking. The researcher marked each question as either correct or incorrect. A mark out of 40 points was written on the top of each test. The mathematics teacher repeated this procedure in the same manner for the second of the Grade 3 classes.

The day after the APST was administered, the mathematics teacher returned the marked tests to the students by means of the student identification numbers. The students were given approximately five minutes to review their work. After the students looked over their tests they were collected. At this time the mathematics teacher administered the MAS. The students completed the questionnaire in their own classroom setting. The students were told that their responses were confidential and that there were no right or wrong answers. The mathematics teacher read each question to the students allowing time for the students to respond after each reading. The questionnaire took approximately 45 minutes to administer. The mathematics teacher collected the questionnaires and recorded the gender and student identification number on each of the papers. The papers were then given to the researcher. The mathematics teacher repeated this procedure in the same manner for the second of the Grade 3 classes.

D. Limitations of the Design

The nature of this study imposed certain limitations on the internal and external validity of the results. This study was not controlled for differences in I.Q. or ethnicity. Differences in the responses of the male and female subjects may be due to variables other than gender and age.

The threat of testing may have created an unsettling feeling for some Grade 3 students. Although the students were assured that the test results would not affect their report card marks, and that there were no right or wrong answers on the questionnaire, students may have felt undue pressure to perform well and to respond in ways that they felt were most acceptable by their teachers and parents.

The modifications made to the MAS may serve as a limitation to the study. The statement, There were times when you were not able to solve the equations, was replaced with the statement, There are times when you just couldn't get the hang of a math lesson, to accommodate for vocabulary differences in younger students. The original statement reflects a computational aspect, while the statement that was used in the study reflects a more theoretical aspect. This discrepancy may serve as a limitation.

External validity may also have been threatened during the study. The subjects in this sample were not randomly selected. They were chosen based on their grade level, age, gender and location. Generalizations may only be made to those children with the same characteristics.

CHAPTER III

ANALYSIS OF RESULTS

A. Data Analysis

The data was analyzed using the Statistical Package for Social Sciences (SPSS) statistical model. T-tests were used in the analysis of the data. The tests were performed as a reflection of the research questions and hypotheses. For descriptive purposes, arithmetic means and standard deviations were reported. A significance level of $p < .05$ was selected for this study. The findings of the study have been organized into two sections. The first section looks at achievement in mathematical problem solving according to gender. The second section examines attributions for mathematical achievement according to gender.

B. Achievement in Mathematical Problem Solving and Gender

Table 1 provided the distribution of gender in both classes. Overall, there were two more males than females. Table 2 provided the average scores based on all 62 students. The scores ranged between 9 and 40, out of a possible 40 marks. The average score of each class was calculated. The difference in achievement between the classes was tested with a t-test (see Table 3). No significant interaction effect for class was found. It was concluded that the two classes did not differ significantly in class averages.

Average male and female scores were examined for the entire sample, as well as separately for each class (see Table 4). In all three groupings the females' average scores were higher than the males' scores. A t-test was used to test whether gender had an effect on test score. Average scores for males and females did not differ significantly at the $p<.05$ level (see Table 5). Thus, it was concluded that gender had no significant effect on test scores.

Table 1 Distribution of Gender by Class

	Male	Female	Total
Class 1	14	14	28
Class 2	18	16	34
Total	32	30	62

Table 2 Average Score

	N	Minimum	Maximum	Mean	Std. Deviation
Score	62	9	40	31.18	8.711

Table 3 T-test for Class and Achievement

Group Statistics

Class	N	Mean	Std. Deviation
Score 1	28	32.46	7.857
2	34	30.12	9.338

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Score					
Equal Variances Assumed	1.116	.295	1.057	60	.295
Equal Variances Not Assumed			1.074	59.963	.287

Table 4 Average Scores

	Class 1	Class 2	Entire Sample
Males			
Mean	32.36	30.11	31.09
Std. Deviation	8.111	9.857	9.064
Females			
Mean	32.57	30.13	31.27
Std. Deviation	7.900	9.040	8.473

Table 5 T-test for Gender and Achievement

Group Statistics

Gender		N	Mean	Std. Deviation
Score	Male	32	31.09	9.064
	Female	30	31.27	8.473

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Score					
Equal Variances Assumed	.068	.795	-.077	60	.939
Equal Variances Not Assumed			-.078	60.000	.938

C. Attributions for Mathematical Achievement and Gender

The students indicated their degree of agreement with various statements related to the four attribution categories; task, environment, effort, and ability. The strength of each attribute as an explanation for the event was rated on a 5-point Likert type scale. The lower the value of the mean, the more agreeable the student was to attribute the cause for the event. A higher mean value corresponded to greater disagreement. Table 6 provided means of the 36 statements for males. The means of the statements for females is found in Table 7. Males strongly agreed with statement number 11 (1.38), which stated that the teacher is good at explaining math and this was the cause for getting the grade they wanted in math on their first term report card. Females were also most agreeable with statement number 11 (1.57), which stated that the teacher was the cause for them getting the grade they wanted in math on their first report card. Both males and females strongly disagreed with statement number 36 (4.47 and 4.53 respectively), which named a lack of time spent doing homework as the cause for not understanding a math lesson.

Eight subscales were created to identify causal attributions for success and failure events. They were: failure due to ability (FA), failure due to effort (FEFF), failure due to the task (FT), failure due to the environment (FEN), success due to ability (SA), success due to effort (SEF), success due to the task (ST), and success due to the environment (SEN). Overall, the students least likely attributed their failure to effort, and most likely attributed their success to the environment (see Table 8).

A t-test was performed to see whether gender had an impact on any of the MAS scales. All of the failure subscales were found to be insignificant at the $p<.05$ level.. Gender had no significant effect on any of the failure subscales. Gender did have a significant effect on the success due to ability (SA) scale ($p=.033$). Males had a significantly lower SA score than females (2.3047 and 2.7917 respectively). It was concluded that males attribute success to ability significantly more than females. All other success subscales were found to be insignificant at the $p<.05$ level (see Table 9).

Table 6 Means of Statements for Males

Statement	N	Minimum	Maximum	Mean	Std. Deviation
1	32	1	5	2.97	1.282
2	32	2	5	3.84	1.019
3	32	1	5	2.78	1.289
4	32	1	5	3.72	1.326
5	32	1	5	2.19	1.306
6	32	1	5	2.66	1.359
7	32	1	5	3.28	1.631
8	32	1	5	2.81	1.355
9	32	1	5	2.16	1.081
10	32	1	5	1.69	1.061
11	32	1	5	1.38	.907
12	32	1	5	2.41	1.241
13	32	1	5	4.03	1.257
14	32	1	5	3.59	1.103
15	32	1	5	3.84	1.221
16	32	1	5	3.25	1.646
17	32	1	5	3.16	1.417
18	32	1	5	4.13	1.100
19	32	1	5	3.81	1.281
20	32	1	5	3.75	1.524
21	32	1	5	2.69	1.203
22	32	1	5	1.91	.963
23	32	1	5	2.06	1.190
24	32	1	5	2.31	1.355
25	32	1	5	2.06	1.105
26	32	1	5	2.09	.995
27	32	1	5	2.31	1.148
28	32	1	5	1.94	1.190
29	32	1	5	3.25	1.481
30	32	1	5	3.50	1.218
31	32	1	5	3.84	1.247
32	32	1	5	4.06	1.162
33	32	1	5	3.00	1.368
34	32	1	5	3.00	1.391
35	32	1	5	3.75	1.437
36	32	1	5	4.47	1.016

Table 7 Means of Statements for Females

Statement	N	Minimum	Maximum	Mean	Std. Deviation
1	30	1	5	3.07	1.311
2	30	2	5	4.10	.885
3	30	1	5	2.73	1.143
4	30	1	5	3.97	1.245
5	30	1	4	1.90	.960
6	30	1	5	3.27	1.015
7	30	1	5	2.53	1.106
8	30	1	5	2.57	1.040
9	30	1	5	2.17	1.085
10	30	1	4	1.70	.877
11	30	1	5	1.57	1.278
12	30	1	5	3.13	1.074
13	30	1	5	3.83	1.117
14	30	2	5	3.57	.679
15	30	2	5	4.27	.740
16	30	1	5	3.73	1.311
17	30	1	5	2.83	1.487
18	30	1	5	3.87	1.306
19	30	2	5	4.33	.884
20	30	1	5	4.13	1.196
21	30	2	5	3.10	.960
22	30	1	4	1.90	.845
23	30	1	5	2.30	1.179
24	30	1	5	2.63	1.474
25	30	1	5	1.87	1.042
26	30	1	5	2.47	1.224
27	30	1	5	2.27	1.172
28	30	1	4	1.90	.845
29	30	1	5	3.13	1.479
30	30	1	5	3.53	1.432
31	30	1	5	3.60	1.303
32	30	1	5	4.10	1.242
33	30	1	5	2.87	1.306
34	30	1	5	3.33	1.373
35	30	1	5	3.97	1.129
36	30	1	5	4.53	.937

Table 8 Means and Standard Deviations of the Eight Subscales

Subscale	N	Minimum	Maximum	Mean	Std. Deviation
FA	62	1.60	4.80	3.3774	.86998
FEFF	62	2.20	5.00	4.0065	.68518
FT	62	1.00	4.60	3.3935	.77075
FEN	62	1.80	5.00	3.7419	.80440
SA	62	1.00	5.00	2.5403	.90671
SEF	62	1.00	4.50	2.2016	.73250
ST	62	1.00	4.00	2.4153	.66212
SEN	62	1.00	4.50	1.9879	.76879

Table 9 T-test for Gender and Attributions

Group Statistics

Subscale	Gender	N	Mean	Std. Deviation
FA	Male	32	3.3125	.96110
	Female	30	3.4467	.77135
FEFF	Male	32	3.9563	.68105
	Female	30	4.0600	.69709
FT	Male	32	3.3375	.84462
	Female	30	3.4533	.69269
FEN	Male	32	3.7438	.87876
	Female	30	3.7400	.73184
SA	Male	32	2.3047	.93700
	Female	30	2.7917	.81496
SEF	Male	32	2.2969	.84347
	Female	30	2.1000	.58942
ST	Male	32	2.3984	.75365
	Female	30	2.4333	.56069
SEN	Male	32	1.9844	.74579
	Female	30	1.9917	.80538

Table 9 T-test for Gender and Attributions - Continued

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
FA Equal variances assumed Equal variances not assumed	1.038	.312	-.604 -.608	60 58.641	.548 .546
FEFF Equal variances assumed Equal variances not assumed	.015	.903	-.593 -.592	60 59.530	.556 .556
FT Equal variances assumed Equal variances not assumed	.218	.642	-.588 -.592	60 58.984	.559 .556
FEN Equal variances assumed Equal variances not assumed	.586	.447	.018 .018	60 59.200	.986 .985
SA Equal variances assumed Equal variances not assumed	1.159	.286	-2.177 -2.187	60 59.677	.033 .033
SEF Equal variances assumed Equal variances not assumed	2.170	.146	1.059 1.071	60 55.584	.294 .289
ST Equal variances assumed Equal variances not assumed	3.057	.086	-.206 -.208	60 57.125	.838 .836
SEN Equal variances assumed Equal variances not assumed	.001	.972	-.037 -.037	60 58.812	.971 .971

The relationship between achievement and attributions for achievement was examined by performing a t-test. The students received percentage marks that corresponded with the Ontario Curriculum requirements for level assessment: Level 1 (50 -59), Level 2 (60-69), Level 3 (70-79) and Level 4 (80-100). Any mark below 50 is given a rating of "R", which signifies a failure and a need for remedial assistance. The students were divided into two level groups. One group consisted of all the students who achieved Level R or 1, and the other group consisted of students who achieved Level 2, 3, or 4. The test revealed that those students who achieved at Level R or 1 had significantly lower failure measures than those students who achieved at Level 2, 3, and 4. The lower achieving students were more likely to attribute their failure to the causes outlined than the higher achieving students. Level of achievement also had a significant effect on the Success due to ability (SA) and Success due to task(ST) scales. Those who achieved at Level R or 1 were less likely to attribute their success to ability or the task, than the higher achieving students. The subscales of Success due to effort (SEF) and Success due to the environment (SEN) did not differ significantly by level; but the lower achieving students scored higher on each of the scales, indicating a greater disagreement. These students were less likely to attribute their success to their effort or to the environment, than the higher achieving students (see Table 10).

The first two events of the Mathematics Attribution Scale (MAS) referred directly to the students' attributions for success and failure on the Achievement in Problem Solving Test (APST) that was administered prior to the MAS. The first event, followed by 4 statements, addressed failure, while the second event, followed by 4 statements, addressed successful achievement on the APST. The attributions of the very low achieving and very high achieving students were examined. T-tests were performed to see whether gender had an effect on statements 1-8 for Level R or 1 students, and Level 4 students. For the Level R or 1 group of students, gender had no significant effect on statements 1-8 (see Table 11). For the Level 4 group of students, the only statement significantly affected by gender was question number 6, which stated that the student is talented in math. Males had a significantly lower score for this statement (2.43) than females (3.30), signifying that males who achieved at Level 4 attributed success on the test to ability more than females who scored at the same level (see Table 12).

Table 10 T-test for Achievement and Attributions

Group Statistics

Level Group	N	Mean	Std. Deviation
FA			
Level R or 1	13	2.4308	.78675
Level 2, 3 or 4	49	3.6286	.70711
FEFF			
Level R or 1	13	3.6769	.70493
Level 2, 3 or 4	49	4.0939	.65967
FT			
Level R or 1	13	2.8615	.83819
Level 2, 3 or 4	49	3.5347	.69449
FEN			
Level R or 1	13	3.1692	.48885
Level 2, 3 or 4	49	3.8939	.80633
SA			
Level R or 1	13	3.0385	.85297
Level 2, 3 or 4	49	2.4082	.88196
SEF			
Level R or 1	13	2.2692	.83205
Level 2, 3 or 4	49	2.1837	.71220
ST			
Level R or 1	13	2.8654	.83301
Level 2, 3 or 4	49	2.2959	.56058
SEN			
Level R or 1	13	2.2308	.72501
Level 2, 3 or 4	49	1.9235	.77427

Table 10 T-test for Achievement and Attributions - Continued

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
FA					
Equal variances assumed	.225	.637	-5.305	60	.000
Equal variances not assumed			-4.981	17.494	.000
FEFF					
Equal variances assumed	.015	.902	-1.998	60	.050
Equal variances not assumed			-1.921	17.981	.071
FT					
Equal variances assumed	.600	.442	-2.974	60	.004
Equal variances not assumed			-2.663	16.631	.017
FEN					
Equal variances assumed	3.630	.062	-3.082	60	.003
Equal variances not assumed			-4.073	31.476	.000
SA					
Equal variances assumed	.187	.667	2.306	60	.025
Equal variances not assumed			2.352	19.383	.029
SEF					
Equal variances assumed	.001	.972	.372	60	.711
Equal variances not assumed			.339	16.958	.739
ST					
Equal variances assumed	9.845	.003	2.922	60	.005
Equal variances not assumed			2.329	15.003	.034
SEN					
Equal variances assumed	.193	.662	1.288	60	.203
Equal variances not assumed			1.339	19.905	.196

Table 11 T-test for Low Achievement, Gender and Attributions

Group Statistics

Statement	Gender	N	Mean	Std. Deviation
1	Male Female	6 7	1.67 2.57	.816 1.512
2	Male Female	6 7	3.50 3.43	1.049 1.397
3	Male Female	6 7	1.67 2.57	1.033 .787
4	Male Female	6 7	2.17 2.86	.753 1.574
5	Male Female	6 7	2.67 2.29	1.506 1.113
6	Male Female	6 7	3.17 3.14	1.169 .900
7	Male Female	6 7	3.00 2.71	1.673 1.113
8	Male Female	6 7	4.00 3.71	.894 .951

Table 11 T-test for Low Achievement, Gender and Attributions - Continued

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
1 Equal variances assumed Equal variances not assumed	2.846	.120	-1.306 -1.368	11 9.463	.218 .203
2 Equal variances assumed Equal variances not assumed	2.131	.172	.103 .105	11 10.853	.920 .918
3 Equal variances assumed Equal variances not assumed	1.616	.230	-1.793 -1.754	11 9.295	.100 .112
4 Equal variances assumed Equal variances not assumed	3.865	.075	-.979 -1.031	11 8.873	.349 .330
5 Equal variances assumed Equal variances not assumed	.283	.605	.524 .512	11 9.113	.610 .621
6 Equal variances assumed Equal variances not assumed	.266	.616	.042 .041	11 9.356	.968 .968
7 Equal variances assumed Equal variances not assumed	1.316	.276	.368 .356	11 8.492	.720 .730
8 Equal variances assumed Equal variances not assumed	.380	.550	.555 .558	11 10.876	.590 .588

Table 12 T-test for High Achievement, Gender and Attributions

Group Statistics

Statement	Gender	N	Mean	Std. Deviation
1	Male Female	21 20	3.48 3.25	1.123 1.293
2	Male Female	21 20	4.10 4.35	.995 .587
3	Male Female	21 20	3.24 2.85	1.179 1.268
4	Male Female	21 20	4.24 4.50	1.136 .827
5	Male Female	21 20	2.19 1.65	1.327 .875
6	Male Female	21 20	2.43 3.30	1.399 1.129
7	Male Female	21 20	3.10 2.50	1.729 1.100
8	Male Female	21 20	2.29 2.15	1.231 .745

Table 12 T-test for High Achievement, Gender and Attributions - Continued

Independent Samples Test

	Levene's Test for Equality of Variance		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
1 Equal variances assumed Equal variances not assumed	.344	.561	.599 .597	39 37.654	.553 .554
2 Equal variances assumed Equal variances not assumed	3.134	.084	-.992 -1.004	39 32.693	.327 .323
3 Equal variances assumed Equal variances not assumed	.007	.934	1.015 1.014	39 38.424	.316 .317
4 Equal variances assumed Equal variances not assumed	2.944	.094	-.840 -.847	39 36.545	.406 .403
5 Equal variances assumed Equal variances not assumed	3.745	.060	1.531 1.546	39 34.793	.134 .131
6 Equal variances assumed Equal variances not assumed	2.168	.149	-2.189 -2.200	39 37.996	.035 .034
7 Equal variances assumed Equal variances not assumed	10.083	.003	1.307 1.321	39 34.125	.199 .195
8 Equal variances assumed Equal variances not assumed	2.455	.125	.424 .429	39 33.187	.674 .670

In summary, males and females differed in their attributions for achievement in mathematics. A statistical significance was evident between gender and attributions for success. Males attributed their success in mathematics to ability significantly more than females. This was true for males in general, as well as high achieving male students.

CHAPTER IV

DISCUSSION

A. Discussion

One purpose of this research was to examine achievement in problem solving in Grade 3 students and to determine if gender related differences existed. The instrument used, the Achievement in Problem Solving Test (APST), focused on the students' ability to choose the correct strategy to accurately solve mathematical word problems. Computational skills were not assessed, as the students were allowed to use calculators to assist them.

When the scores of the two classes were analyzed, it was found that the classes did not differ significantly in their achievement. With regard to gender differences, there was no statistically significant difference between the males' and females' achievement. Although the t-test performed did not detect a significant difference, when the means were looked at, it showed that females scored higher than males in both classes and overall. The finding that males and females do not differ in their problem solving achievement in an early elementary grade is supported by research conducted by Hyde, Fennema and Lamon (1990).

The second purpose of this research was to examine attributions for mathematical problem solving achievement in Grade 3 students and to determine if gender related differences existed. The students' responses to the 36 statements reflected a strong sense of effort being put forth toward mathematics work. Both males and females strongly disagreed with the statement that claimed that a lack of time spent doing homework was the cause for not understanding a math lesson. This perception of hard work and a great deal of time spent doing mathematics homework may reflect the increased emphasis on mathematics in Ontario's curriculum. Males strongly agreed that the teacher's explanations of the mathematical concepts was the cause for getting the grades they wanted in math on their first term report cards. Females suggested that the time spent at home doing math was the most likely reason they got the marks they wanted in math. In both success and failure events, females implied they had spent a great deal of time doing mathematics in order to achieve their results.

The four attributional categories: ability, effort, task difficulty, and the environment were combined with success and failure events to create eight subscales. In regard to gender and attributional causes, all of the failure subscales were found to be insignificant. Males and females did not differ in what they attributed their failure to. Both genders chose their ability, or lack of it, as the most likely cause for their failure. According to Weiner (1974), in selecting ability as the most likely cause of failure, the students have indicated that their achievement is external and out of their control. This perception may result in performance decrements (Weiner, 1994).

Success attributions for effort, task difficulty and environment did not yield statistically significant results. Both genders were most likely to attribute their success to the environment. The environment is comprised of such things as the teacher's influence and luck, and considered to be an external, uncontrollable cause by attribution theorists. The absence of effort as a strong attributional cause for success by either gender, raises the issue of the teacher's role in mathematics education. The students perceived the teacher as the reason for their success, rather than their own efforts. The implications for teachers will be discussed in the recommendations.

Success attributions for ability did show a statistically significant difference according to gender. Males attributed success to ability significantly more than females. This finding has been supported by many other researchers (Eccles et al., 1983; Licht & Dweck, 1984; Parsons, 1983; Parsons, Meece et al., 1982; Pedro et at., 1981; Ryckman & Peckham, 1987; Stipek, 1984; Stipek & Gralinski, 1991; Tapasak, 1990; Wolleat et al., 1980). In Stipek's study (1984) as well, the males' and females' scores on math tests did not differ significantly, although attributions for success did.

When the students' scores were grouped according to achievement levels, it was found that approximately the same number of males and females scored at the highest level, Level 4. In examining the attributions for success held by the high achieving students, a significant gender difference was discovered. Although all of the students in this group scored at the highest level, the males attributed success on the test to ability more than females. A possible explanation for this discrepancy in self confidence may be society's belief that mathematics is a male domain. This belief may have penetrated educators' and parents' views, resulting in the perception that males are more mathematically able than females. A more in depth study of these possible societal influences is needed.

B. Recommendations

Based on the findings of this study, recommendations for further research as well as educators have been proposed.

Future Research

1. The study should be replicated to include the entire population of Grade 3 students within the school board. A larger sample size would help obtain a more representative sample of students.
2. The study should be replicated within another school board outside the province of Ontario. This would allow for comparison between samples and between mathematics teaching practices and emphasis.
3. A follow-up study would be beneficial in order to detect if and when males and females begin to differ in their mathematical problem solving ability.
4. Males, as early as in third grade, attribute their success to ability more strongly than females. A future study should be conducted with second grade students to help establish when this difference first emerges.

Educators

1. A greater awareness of educators' own views and beliefs toward mathematical attributions need to examined. School based workshops and seminars regarding mathematical ability, reasoning, and gender need to be offered to school personnel.
2. The belief of students, that they are in control of their outcomes is very important to future endeavours. Educators need to emphasize the importance of effort by students. Students need to feel in control of their successes and failures and feel that they are able to alter their outcomes if necessary.
3. Programs in schools need to encourage greater female participation in

mathematics related activities. Math clubs, fairs, and competitions need to be promoted to include females as well as males.

CHAPTER V

REFERENCES

Ablard, K. E., Tissot, S. L., & Mills, C. J. (1992). Academically talented students' precocious cognitive development and its predictors. Unpublished manuscript, Johns Hopkins University, Baltimore.

Anastasi, A. (1958). Differential psychology: Individual and group differences in behavior (3rd ed.). New York: Macmillan.

Armstrong, J. M. (1986). A national assessment of participation and achievement of women in mathematics. In S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 59-94). Hillsdale, NJ: Erlbaum.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Benbow, C. P. (1988). Sex differences in mathematical reasoning ability in intellectually talented preadolescents: Their nature, effects, and possible causes. Behavioral and Brain Sciences, 11, 169-183.

Benbow, C. P. (1992). Academic achievement in mathematics and science of students between ages 13 and 23: Are there differences among students in the top one percent of mathematical ability? Journal of Educational Psychology, 84, 51-61.

Benbow, C. P., & Stanley, J. C. (1980). Sex differences in mathematical ability: Fact or artifact? Science, 210, 1262-1264.

Carr, M., & Jessup, D. L. (1997). Gender differences in first-grade mathematics strategy use: Social and metacognitive influences. Journal of Educational Psychology, 89 (2), 318-328.

Clewell, B. C., Anderson, B. T., & Thorpe, M. E. (1992). Breaking the barriers: Helping female and minority students succeed in mathematics and science. San Francisco, CA: Jossey-Bass Publishers.

Cooper, H. M., Burger, J. M., & Good, T. L. (1981). Gender differences in the academic locus of control beliefs of young children. Journal of Personality and Social Psychology, 40 (3), 562-572.

Donlon, T., Ekstrom, R., & Lockheed, M. (1976, September). Comparing the sexes on achievement items of varying content. Paper presented at the meeting of the American Psychological Association, Washington, DC.

Dossey, J. A., Mullins, I. V. S., Lindquist, M. M., & Chambers, D. L. (1988). The mathematics report card: Are we measuring up? Trends and achievement based on the 1986 National Assessment. Princeton, NJ: The Nation's Report Card, NAEP, Educational Testing Service.

Duffy, J., Gunter, G., & Walters, L. (1997). Gender and mathematical problem solving. Sex Roles, 37, 477-494.

Dweck, C. S. (1975). The role of expectations and attributions in the alleviation of learned helplessness. Journal of Personality and Social Psychology, 31, 674-685.

Dweck, C. S., Davidson, W., Nelson, S., & Enna, B. (1978). Sex differences in learned helplessness: (II) The contingencies of evaluative feedback in the classroom and (III) An experimental analysis. Developmental Psychology, 14, 268-276.

Dweck, C. S., & Goetz, T. E. (1978). Attributions and learned helplessness. In J. Harvey, W. Ickes, & R. Kidd (Ed.), New directions in attribution research (Vol. 2). Hillsdale, NJ: Erlbaum.

Dweck, C. S., & Licht, B. G. (1980). Learned helplessness and intellectual achievement. In J. Garber & M. E. P. Seligman (Eds.), Human helplessness: Theory and application. New York: Academic Press.

Dweck, C. S., & Reppucci, N. D. (1973). Learned helplessness and reinforcement responsibility in children. Journal of Personality and Social Psychology, 25, 109-116.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., & Midgley, C. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), Achievement and achievement motives (pp. 75-146). San Francisco: Freeman.

Eccles, J. S., Wigfield, A., Flanagan, C., Miller, C., Reuman, D., & Yee, D. (1989). Self-concepts, domain, values, and self-esteem: Relations and changes at early adolescence. Journal of Personality, 57, 283-310.

Eccles, J. S., Wigfield, A., Harold, R., & Blumenfeld, P. (1993). Age and gender differences in children's achievement in self-perceptions during the elementary school years. Child Development, 64, 830-847.

Education Quality and Accountability Office. (2001). EQAO Ontario Provincial Report on Achievement, 2000-2001. Education Quality and Accountability Office, Toronto, Ontario.

Ethington, C. (1990). Gender differences in mathematics: An international perspective. Journal for Research in Mathematics, 21, 74-80.

Feingold, A. (1988). Cognitive gender differences are disappearing. American Psychologist, 43, 95-103.

Fennema, E. (1974). Mathematics learning and the sexes: A review. Journal for Research in Mathematics Education, 5, 126-139.

Fennema, E., & Carpenter, T. P. (1981). Sex-related differences in mathematics: Results from national assessment. Mathematics Teacher, 74, 554-566.

Fennema, E., Carpenter, T. P., Jacobs, V. R., Franke, M. L., & Levi, L. W. (1988). A longitudinal study of gender differences in young children's mathematical thinking. Educational Researcher, 27 (5), 6-11.

Fennema, E., & Sherman, J. (1977). Sex-related differences in mathematics, achievement, spatial visualization and affective factors. American Educational Research Journal, 14, 51-71.

Fennema, E., & Sherman, J. (1978). Sex-related differences in mathematical achievement and related factors: A further study. Journal for Research in Mathematics Education, 9, 189-203.

Fennema, E., Wolleat, P. L., & Pedro, J. D. (1979). Mathematics attribution scale: An instrument designed to measure student's attributions of the causes of their successes and failures in mathematics. Washington, DC: American Psychological Association, JSAS Catalog of Selected Documents in Psychology, 9 (2), 26.

Frieze, I. H., Fisher, J., Hanusa, B., McHugh, M. C., & Valle, V. A. (1978). Attributions of the causes of success and failure as internal and external barriers to achievement in women. In J. A. Sherman & F. L. Denmark (Eds.), The psychology of women: Future directions in research. New York: Psychological Dimensions.

Gallagher, A. M., & De Lisi, R. (1994). Gender differences in scholastic aptitude test - Mathematics problem solving among high-ability students. Journal of Educational Psychology, 86 (2), 204-211.

Gipps, C., & Tunstall, P. (1998). Effort, ability and the teacher: Young children's explanations for success and failure. Oxford Review of Education, 24 (2), 149-165.

Harter, S. (1982). The perceived competence scale for children. Child Development, 53, 87-97.

Harter, S. (1983). Developmental perspectives on the self-system. In P. H. Mussen (Ed.), Handbook of child psychology, (4th ed., Vol. 4, pp. 275-385). New York: Wiley.

Harter, S., & Pike, R. (1984). The pictorial scale of perceived competence and social acceptance for young children. Child Development, 55, 1969-1982.

Hilton, T., & Berglund, G. (1974). Sex differences in mathematics achievement- A longitudinal study. Journal of Education Research, 67, 231-237.

Hyde, J. S. (1981). How large are cognitive gender differences? American Psychologist, 36, 892-901.

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance: A meta-analysis. Psychological Bulletin, 107, 139-155.

Kaczala, C. M., Parsons, J. E., Futterman, R., & Meece, J. (1979).

Developmental shifts in expectancies and attributions for performance in mathematics. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.

Keating, D. P. (1975). Precocious cognitive development at the level of formal operations. Child Development, 46, 276-280.

Leder, G. C. (1992). Mathematics and gender: Changing perspectives. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 597-622). New York: Macmillan.

Licht, B. G., & Dweck, C. S. (1984). Determinants of academic achievement: The interaction of children's achievement orientations with skill area. Developmental Psychology, 20, 628-636.

Lummis, M., & Stevenson, H. W. (1990). Gender differences in beliefs and achievement: A cross-cultural study. Developmental Psychology, 26 (2), 254-263.

Maccoby, E. E. (Ed.). (1966). The development of sex differences. Stanford, CA: Stanford University Press.

Maccoby, E. E., & Jacklin, C. N. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

Maier, N. R. F., & Casselman, G. G. (1971). Problem-solving ability as a factor in selection of major in college: Comparison of the processes of idea-getting and making essential distinctions in males and females. Psychological Reports, 28, 503-514.

Marsh, H. W. (1989). Age and sex effects in multiple dimensions of self-concept: Preadolescence to early adulthood. Journal of Educational Psychology, 81, 417-

430.

Marsh, H. W. (1993). Physical fitness self-concept: Relations of physical fitness to field and technical indicators for boys and girls aged 9-15. Journal of Sport and Exercise Psychology, 15, 184-206.

Marsh, H. W., Barnes, J., Cairns, L., & Tidman, M. (1984). Self description questionnaire: Age and sex effects in the structure and level of self-concept for preadolescent children. Journal of Educational Psychology, 76, 940-956.

Marsh, H. W., Craven, R. G., & Debus, R. (1991). Self-concepts of young children 5 to 8 years of age: Measurement and multidimensional structure. Journal of Educational Psychology, 83, 377-392.

Marshall, S. P. (1984). Sex differences in mathematics achievement: Solving computations and story problems. Journal of Educational Psychology, 14, 194-204.

Marshall, S. P., & Smith, J. D. (1987). Sex differences in learning mathematics: A longitudinal study with item and error analyses. Journal of Educational Psychology, 79, 372-383.

Meece, J., & Jones, G. (1996). Girls in mathematics and science: Constructivism as a feminist perspective. The High School Journal, 79 (3), 242-249.

Mills, C. J., Ablard, K. E., & Stumpf, H. (1993). Gender differences in academically talented young students' mathematical reasoning: Patterns across age and subskills. Journal of Educational Psychology, 85 (2), 340-346.

Nicholls, J. G. (1980). A re-examination of boys' and girls' casual attributions for success and failure based on New Zealand data. In L. Fyans (Ed.), Achievement motivation: Recent trends in theory and research. New York: Plenum Press.

Nicholls, J. G. & Miller, A. T. (1983). The differentiation of the concepts of difficulty and ability. Child Development, 54, 951-959.

Parsons, J. E. (1980). Attributions as mediators of attitudes toward mathematics. Paper presented at the meeting of the American Educational Research Association, Boston, MA.

Parsons, J. E. (1983). Attributions, learned helplessness, and sex differences in achievement. Journal of Educational Equity and Leadership, 3, 19-27.

Parsons, J. E., Kaczala, C., & Meece, J. (1982). Socialization of achievement attitudes and beliefs: Classroom influences. Child Development, 53, 322-339.

Parsons, J. E., Meece, J. L., Adler, T. F., & Kaczala, C. M. (1982). Sex differences in attributional patterns and helplessness? Sex Roles, 8, 421-432.

Parsons, J. E., & Ruble, D. N. (1977). The development of achievement-related expectancies. Child Development, 48, 1075-1079.

Pedro, J. D., Wolleat, P., Fennema, E., & Becker, A. D. (1981). Election of high school mathematics by females and males: Attributions and attitudes. American Educational Research Journal, 18, 207-218.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. Journal of Educational Psychology, 79, 384-387.

Porter, R. C. (1999, January). Gender differences in mathematics performance. Paper presented at the Annual Holmes Partnership Conference, Boston, MA.

Reyes, L. (1984). Affective variables and mathematics education. Elementary School Journal, 84, 558-581.

Robitaille, D. F. (1977). A comparison of boys' and girls' feelings of self-confidence in arithmetic computation. Canadian Journal of Education, 2, 15-22.

Robitaille, D. F., & Sherrill, J. M. (1979). Achievement results from the B.C. mathematics assessment. Canadian Journal of Education, 4, 39-53.

Ryckman, D., & Peckham, P. (1996). Gender differences in attributions for success and failure. Journal of Early Adolescence, 7, 47-63.

Seegers, G., & Boekaerts, M. (1996). Gender-related differences in self-referenced cognitions in relation to mathematics. Journal for Research in Mathematics Education, 27 (2), 215-240.

Sherman, J. (1980). Mathematics, spatial visualization, and related factors: Changes in girls and boys, grades 8-11. Journal of Educational Psychology, 72, 476-482.

Stanley, J. C., & Benbow, C. P. (1986). Youths who reason exceptionally well mathematically. In R. J. Sternberg & J. Davison (Eds.), Conceptions of giftedness. (pp. 361-387). Cambridge, England: Cambridge University Press.

Stipek, D. J. (1984). Sex differences in children's attributions for success and failure on math and spelling test. Sex Roles, 11, 969-981.

Stipek, D. J., & Gralinski, H. (1991). Gender differences in children's achievement-related beliefs and emotional responses to success and failure in mathematics. Journal of Educational Psychology, 83 (3), 361-371.

Stipek, D. J., & Mac Iver, D. (1989). Developmental change in children's assessment of intellectual competence. Child Development, 60, 521-538.

Tapasak, R. C. (1990). Differences in expectancy-attribution patterns of cognitive components in male and female math performance. Contemporary Educational Psychology, 15, 284-298.

Tyler, L. E. (1956). The psychology of human differences (2nd ed.). New York: Appleton-Century-Crofts.

Tyler, L. E. (1969). Sex differences. In R. L. Ebel (Ed.), Encyclopedia of educational research (4th ed., pp. 1217-1221). Toronto, ON: Macmillan.

Vanayan, M., White, N., Yuen, P., & Teper, M. (1997). Beliefs and attitudes toward mathematics among third-and-fifth-grade students: A descriptive study. School Science and Mathematics, 97 (7), 345-351.

Weiner, B. (1974). Achievement motivation and attribution theory. Morristown, NJ: General Learning Press.

Weiner, B. (1986). An attributional theory of motivation and emotion. New York: Springer-Verlag.

Weiner, B. (1994). Integrating social and personal theories of achievement striving. Review of Educational Research, 64 (4) 557-573.

Weiner, B., Frieze, I., Kukla, A., Reed, L., Rest, S., & Rosenbaum, R. M. (1971). Perceiving the causes of success and failure. New York: General Learning Press.

Weiner, N. C., & Robinson, S. e. (1986). Cognitive abilities, personality and gender differences in math achievement of gifted adolescents. Gifted Child Quarterly, 30, 83-87.

Wigfield, A., Eccles, J., Mac Iver, D., Reuman, D., & Midgley, C. (1991). Transitions at early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. Developmental Psychology, 27, 552-565.

Wigfield, A., Eccles, S. J., Suk Yoon, K., Harold, R. D., Arbreton, A. J. A., Freedman-Doan, C., & Blumenfeld, P. C. (1997). Change in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. Journal of Educational Psychology, 89 (3), 451-469.

Wolleat, P. H., Pedro, J. D., Becker, A. D., & Fennema, E. (1980). Sex differences in high school students' causal attributions of performance in mathematics. Journal for Research in Mathematics Education, 11 (5), 356-366.

CHAPTER VI

APPENDIXES

APPENDIX A

ACHIEVEMENT IN PROBLEM SOLVING TEST

______ Please circle either MALE or FEMALE

Directions: Read the questions carefully. Answer the questions, showing the calculations used.

1.A Grade 3 classroom has 32 students. There are 5 children absent from school today. How many children in the Grade 3 class are at school today?

2. Tina's mother bought 5 packages of balloons for her party. There were 8 balloons in each package. How many balloons were there in all?

3. 26 students went on the field trip to the zoo. 16 students stayed at school. How many students were there in all?

4. Last month the Cycle Shop sold 69 bikes. The month before, they sold 58. How many more did they sell last month?

5. 24 people were waiting at the ticket counter to buy tickets. There were 4 people in each line. How many lines were there?

6. Six friends went to the movies. The total cost of their tickets was $42. The tickets were all the same price. How much did each ticket cost?

7. June planted 24 tulips in her garden. Her mother planted 36 daffodils. How many flowers did they plant together?

8. Susan is 127 cm tall and has brown hair. Tom is 95 cm tall and has blonde hair. How much taller is Susan than Tom?

9. Denise has 6 seed boxes. She will plant 6 tomato seeds in each. How many seeds are needed?

10. Jenny picked up 3 oak leaves. She then picked up 7 maple leaves. How many oak and maple leaves did Jenny have altogether?

11. Paula has 32 fish bowls to put on the shelves at the pet store. One shelf holds 8 bowls. How many shelves did Paula need?

12. We have 7 paint jars in a box. There are 3 boxes of paint jars. How many paint jars are there?

13. It takes Mrs. Flowersbee eight minutes to make a bouquet of flowers. How long does it take her to make 5 bouquets?

14. A burger at The Burger Shack costs $2. How many burgers can be bought for $12?

15. Nicole has 8 blue pens in her pencil case. She also has 3 red pens. How many more blue pens than red pens does Nicole have?

16. Peter has 69 marbles. He won 32 more. How many marbles did he have altogether?

17. There are 9 apartments in the building across the street. Each apartment has 4 people. How many people are in the building across the street?

18. At the pet store, one kitten cost $18.00. Another kitten cost $9.00. What was the cost of the 2 kittens?

19. Five children shared a bag of 40 candies. How many candies should each child get, if they are shared equally?

20. 18 children are divided into teams of 3. How many teams are there?

21. A parking lot has spaces for 180 cars. There were 163 cars in the parking lot. How many empty spaces were there?

22. Nancy put 7 books on each shelf. She used 4 shelves. How many books were on the shelves?

23. There are 28 houses on one side of the street and 25 on the other. How many houses are on the street?

24. Ted can put all his marbles into his pockets. He can put 55 marbles in one pocket and 46 marbles in the other. How many marbles does he have?

25. At the carnival you can buy tokens for rides. It cost $1 for 3 tokens. How much will it cost for 12 tokens?

26. Sally brought her camera to the school picnic. She took 4 rolls of pictures. Each roll has 10 pictures. How many pictures did she take?

27. There are 13 more purple candies than green candies in the bowl. There are 19 green candies. How many purple candies are there?

28. The children had 115 trees to plant on Tree Day. 23 of the trees they planted were spruce. The rest of the trees were pine. How many pine trees did they have to plant?

29. The salesperson at the pet store sold 4 goldfish bowls on Friday. She sold 8 on Saturday. How many more goldfish bowls were sold on Saturday than Friday?

30. 36 pencils are shared by 9 children. How many pencils does each child get?

31. David planted 9 geranium seeds in each of 3 boxes. If all the seeds grow, how many plants will there be?

32. There are 168 children who live in an apartment building. There are 320 people in all. How many adults are there?

33. Mr. Lee planted 26 bushes one day. He planted 18 the next day. How many did he plant altogether?

34. The Smith family had to drive 87 km to get to the campground. They stopped to buy ice when they had gone 65 km. How much farther did they have to drive?

35. It takes 6 days to paint an apartment. How many days does it take to paint 3 apartments?

36. The pet store had 5 bird cages. There were 6 birds in each cage. How many birds were there?

37. 18 muffins are shared by 9 people. How many does each person get?

38. The students in Mr. White's class collected pop cans. They collected 87 orange pop cans and 54 cola cans. How many cans did they collect?

39. At the barbeque 62 burgers were cooked. Only 4 were left over. How many burgers were eaten at the barbeque?

40. There are 21 cookies. 7 are placed in each bag. How many bags are needed?

APPENDIX B

MATHEMATICS ATTRIBUTION SCALE

_______ Please circle either MALE or FEMALE

You are going to read about an event which could have happened to you. In addition, you are going to see four possible causes of that event. You are going to respond to how you feel about whether the causes listed could really explain the event if it had happened to you. Each event and its possible causes are listed in a group. In each group an event is followed by four possible causes. You are to read the event carefully and then respond to how you feel about each of the causes of the event.

SPECIFIC TO THE ACHIEVEMENT IN PROBLEM SOLVING TEST

Event A: You got some of the questions on the problem solving test wrong.

	Causes	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1.	You just couldn't figure out which operation to use.	A	B	C	D	E
2.	You were careless when you were doing it.	A	B	C	D	E
3.	The questions that were wrong were the most difficult ones.	A	B	C	D	E
4.	You were unlucky.	A	B	C	D	E

Event B: You have passed the problem solving test with no trouble.

	Causes	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
5.	The teacher made learning how to problem solve fun.	A	B	C	D	E
6.	Like everyone says, you're talented in math.	A	B	C	D	E
7.	You spent extra time doing word problems.	A	B	C	D	E
8.	The test was easy.	A	B	C	D	E

GENERAL ACHIEVEMENT IN MATHEMATICS

Event C: You got the grade you wanted in math on your first term report card.

Causes

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
9.	The math you have to do is easy.	A	B	C	D	E
10.	You spend time at home doing math.	A	B	C	D	E
11.	The teacher is good at explaining math.	A	B	C	D	E
12.	You have a special talent for math.	A	B	C	D	E

Event D: You had trouble with the math seatwork assigned today.

Causes

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
13.	There wasn't enough time to get help from the teacher.	A	B	C	D	E
14.	You don't think the way that you need to in order to do math.	A	B	C	D	E
15.	You didn't take time to check examples the teacher showed you.	A	B	C	D	E
16.	They were difficult problems.	A	B	C	D	E

Event E: You have not been able to keep up with most of the class in math.

Causes

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
17.	Students around you disturbed you.	A	B	C	D	E
18.	You haven't spent much time working on it.	A	B	C	D	E
19.	The work is difficult.	A	B	C	D	E
20.	You have always had a hard time in math.	A	B	C	D	E

Event F: You have been easily able to do your last few math assignments.

<u>Causes</u>

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
21.	The questions were more interesting.	A	B	C	D	E
22.	The effort you put in your earlier assignments helped.	A	B	C	D	E
23.	You are a very good math student.	A	B	C	D	E
24.	You were lucky to work with a helpful group.	A	B	C	D	E

Event G: You were able to understand a difficult math unit.

<u>Causes</u>

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
25.	The way the teacher taught it helped.	A	B	C	D	E
26.	Your talent for math shows more when you are challenged.	A	B	C	D	E
27.	You studied harder.	A	B	C	D	E
28.	The questions were easy because you had done similar ones before.	A	B	C	D	E

Event H: You received a low grade on a test.

<u>Causes</u>

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
29.	You're not the best student in math.	A	B	C	D	E
30.	You studied, but not hard enough.	A	B	C	D	E
31.	There were questions you'd never seen before.	A	B	C	D	E
32.	The teacher hadn't spent enough time on it in class.	A	B	C	D	E

Event I: There were times when you just couldn't get the hang of a math lesson.

<u>Causes</u>

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
33.	It was a lesson that didn't interest you.	A	B	C	D	E
34.	Even though you studied, you still didn't understand it.	A	B	C	D	E
35.	Your friends didn't pay attention in class and that was part of the problem.	A	B	C	D	E
36.	You didn't spend time doing homework.	A	B	C	D	E

APPENDIX C

XXX XXXXXX XXXXX XX
LaSalle, Ontario
XXX XXX

Dr. X XXXXXX
Chair of the Ethics Committee
Faculty of Education, University of Windsor
Windsor, Ontario

Dear Dr. XXXXXX,

As a graduate student at the University of Windsor in the Faculty of Education, I am writing to request approval from the Ethics Committee to conduct a research study which will fulfill the thesis requirements for the degree of Master of Education.

The study will investigate the relationships between gender and achievement in mathematical problem solving, and attributions for mathematical achievement in third grade students. There are no known risks associated with this study and all information will be kept confidential. Participation is voluntary and participants may withdraw from the study at any time. Enclosed is a copy of the research petition, which outlines the procedures to be followed, and letters of permission and consent.

If you have any questions, please contact me at XXX-XXXX. My advisor, Dr. McKay will be pleased to answer any questions you may have. You can contact her at XXX-XXXX, ext. XXXX.

Thank you for taking the time to review my research petition. I look forward to your response.

Sincerely,

APPENDIX D

XXX XXXXXX XXXXX XX
LaSalle, Ontario
XXX XXX

XXX XXXXX XXXXXXXXX
Superintendent of Education/Curriculum
XXXXXXX-XXXXXXXX XXXXXXX XXXXXXXX School Board
Windsor, Ontario

Dear XXX XXXXXXXXX,

As a graduate student at the University of Windsor in the Faculty of Education, I am writing to request your approval to conduct a research study which will fulfill the thesis requirements for the degree of Master of Education.

The study will investigate the relationships between gender and achievement in mathematical problem solving, and attributions for mathematical achievement in third grade students. There are no known risks associated with this study and all information will be kept confidential. Participation is voluntary and participants may withdraw from the study at any time. Approval has been granted from the Graduate Studies Department at the University of Windsor, as well as the Ethics Committee.

I have attached a copy of the research petition as well as the letter of consent which will be used to obtain consent from parents of the participants. I have also sent a hard copy of the entire petition through the courier. You should be receiving it in the next couple of days.

If you have any questions, please contact me either at work at XXX XXXX XX XXXXX XXXXXX School, or at home at XXX-XXXX. My advisor, Dr. McKay, is also available at XXX-XXXX, ext. XXXX to answer any questions you may have.

Thank you for taking the time to review my research petition. I look forward to your response.

Sincerely,

APPENDIX E

XXX XXXXXXX XXXXX XX
LaSalle, Ontario
XXX XXX

Mr. XXXX XXXXX (Principal)
XXX XXXX XX XXXXX XXXXXX School
XXXX XXXXXXXXX XX
Windsor, Ontario
XXX XXX

Dear Mr. XXXXX,

As a graduate student at the University of Windsor in the Faculty of Education, I am writing to request your approval to conduct a research study which will fulfill the thesis requirements for the degree of Master of Education.

The study will investigate the relationships between gender and achievement in mathematical problem solving, and attributions for mathematical achievement in third grade students. There are no known risks associated with this study and all information will be kept confidential. Participation is voluntary and participants may withdraw from the study at any time. Approval has been granted from the Graduate Studies Department at the University of Windsor, as well as the Ethics Committee. Permission has also been granted from the XXXXXXX-XXXXX XXXXXXXX XXXXXXXX School Board.

You will find a copy of my research petition as well as letters of permission on the bbs. If you have any questions, please contact me at XXX-XXXX or my advisor, Dr. McKay. Dr. McKay can be reached at XXX-XXXX, ext. XXXX.

Thank you for taking the time to review my research petition. I look forward to your response.

Sincerely,

APPENDIX F

XXX XXXXXX XXXXX XX
LaSalle, Ontario
XXX XXX

Mr. XXXXX XXXXX and Mr. XXXXX XXXXXXXXXX
Grade Three Teachers
XXX XXXX XX XXXXX XXXXXX School
XXXX XXXXXXXXX XX
Windsor, Ontario
XXX XXX

Dear Mr. XXXXX and Mr. XXXXXXXXXX,

As a graduate student at the University of Windsor in the Faculty of Education, I am writing to request your approval to conduct a research study which will fulfill the thesis requirements for the degree of Master of Education.

The study will investigate the relationships between gender and achievement in mathematical problem solving, and attributions for mathematical achievement in third grade students. There are no known risks associated with this study and all information will be kept confidential. Participation is voluntary and participants may withdraw from the study at any time. Enclosed is a copy of research petition, which outlines the procedures to be followed, and letters of permission and consent.

If you have any questions, please contact me at XXX-XXXX or my advisor, Dr. McKay. Dr. McKay can be reached at XXX-XXXX, ext. XXXX.

Thank you for taking the time to review my research petition. Your support in this study is greatly appreciated.

Sincerely,

APPENDIX G

CONSENT TO PARTICIPATE IN RESEARCH

THE RELATIONSHIP BETWEEN GENDER AND ACHIEVEMENT IN MATHEMATICAL PROBLEM SOLVING AND ATTRIBUTIONS FOR MATHEMATICAL ACHIEVEMENT IN GRADE THREE STUDENTS

Your child is asked to participate in a research study conducted by XXXXXXX XXXXXXX, under the supervision of Dr. Linda McKay, from the Faculty of Education at the University of Windsor. Results of the study will contribute to the fulfillment of the degree of Master of Education for XXXXXXX XXXXXXX.

If you have any questions or concerns about the research, please feel free to contact XXXXXXX XXXXXXX at either XXX-XXXX or XXX-XXXX or Dr. Linda McKay at XXX-XXXX, ext. XXXX.

PURPOSE OF THE STUDY
This study is designed to examine if a relationship exists between gender and achievement in mathematical problem solving in Grade 3 students. It will also examine if a relationship exists between gender and attributions for achievement in mathematical problem solving in Grade 3 students.

PROCEDURES
The students of two intact Grade 3 classrooms at XXX XXXX XX XXXXX XXXXXX School will participate in the study. The students will complete a paper and pencil test, The Achievement in Problem Solving Test, administered by Mr. XXXXX XXXXXXXXXX. It consists of 40 mathematical word problems. The students will be allowed to use calculators to assist them. The students will be asked to record all of their work, to show how they arrived at their answers. The test will be completed in their regular classroom setting, during their regularly scheduled mathematics time period. The test will take approximately one hour to complete. Mr. XXXXXXXXXX will be available to read the questions to students if difficulties in reading arises. Mr. XXXXXXXXXX will assure the students that this test will have no bearing on their report cards.
Approximately two days later, the marked tests will be returned to the students by means of an anonymous number system. The students will find a mark out of 40 on the top of their tests. After giving about five minutes to review their tests, Mr. XXXXXXXXXX will administer a questionnaire to the students. This questionnaire is called The Mathematics Attribution Scale. It is designed to examine students' attributions for mathematical achievement. Mr. XXXXXXXXXX will read each question to the class, and allow time for response, in the form of a circle on the questionnaire. The questionnaire will take approximately thirty minutes to complete. It will be completed in their regular classroom setting, during the regularly scheduled mathematics time period.

The students will be told that their answers are confidential and that there are no right or wrong answers.
All parents/legal guardians will be able to view the results of the study. The results will be posted outside the principal's office of XXX XXXX XX XXXXX XXXXXXX School.

POTENTIAL BENEFITS TO SUBJECTS AND TO SOCIETY

Benefits to the students involved in the study include the opportunity to reflect on their learning and to examine their attributions for success and failure.
The area of problem solving is highly stressed in today's mathematics curriculum. If a relationship between gender and achievement exists, adjustments to teaching practices and approaches may be altered to aid in student success. Feedback concerning attributions may result in teachers examining their own views and daily practices. Overall, increased knowledge about mathematical achievement and gender may result in improved mathematical performance across school boards.

PAYMENT FOR PARTICIPATION

The subjects of this study will not receive payment for their participation.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission. The paper and pencil test, The Achievement in Problem Solving Test, as well as the questionnaire, The Mathematics Attribution Scale, will only have one distinguishing feature- gender. The subjects will be asked to circle either male or female. Names will not be written on the papers. The students will be assigned a number which will assist in returning the problem solving tests to the rightful owners. The investigator of the study will not be able to connect the students to the tests. When papers are collected they will be placed in an envelope which Mr. XXXXXXXXXXX will give to the investigator. To secure the records, data will be kept locked and accessible only to the investigator and supervising faculty members at the University of Windsor. All records will be shredded at the end of the study.

PARTICIPATION AND WITHDRAWAL

You can choose whether or not your child is to be in this study or not. If you volunteer your child to be in this study, your child may withdraw at any time without consequences of any kind. You may exercise the option of removing your child's data from the study. Your child may also refuse to answer any questions he/she does not want to answer and still remain in the study. The investigator may withdraw your child from this research if circumstances arise which warrant doing so.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue your child's participation without penalty. This study has been reviewed and received ethics clearance through the University of Windsor Research Ethics Board. If you have any questions regarding your child's rights as a research subject, contact:

Research Ethics Co-ordinator Telephone: 519-253-3000, # 3916
University of Windsor
Windsor, Ontario
N9B 3P4

SIGNATURE OF PARENT/LEGAL GUARDIAN

I understand the information provided for the study "The Relationship Between Gender and Achievement in Mathematical Problem Solving and Attributions for Mathematical Achievement in Grade Three Students" as described herein. My questions have been answered to my satisfaction, and I agree to have my child participate in this study. I have been given a copy of this form.

____
Name of Subject

____
Name of Parent/Legal Guardian

______________________________ ______________
Signature of Parent/Legal Guardian Date

APPENDIX H

LETTER OF ASSENT - ACHIEVEMENT IN PROBLEM SOLVING TEST

The study has been explained to me. I understand that I am being asked to complete a mathematics test consisting of forty different word problems. I am allowed to use a calculator, but I need to show all of my work when answering the questions. In a couple of days I will receive a mark out of forty points, indicating the amount of questions I have answered correctly. I understand that this mark will not have any bearing on my report card. The mark is only going to be used for this study. I also understand that my name will not be written on the test, so no one will know that the test is mine. If I have trouble reading words on the test, the words will be read to me.

□ Yes, I agree to participate in the study. I will complete the mathematics test.

Signature ____

□ No, I do not agree to participate in the study. I will not complete the mathematics test.

Signature ____

APPENDIX I

LETTER OF ASSENT - MATHEMATICS ATTRIBUTION SCALE

The study has been explained to me. I understand that I am being asked to complete a questionnaire about my results on the mathematics word problem test I completed a couple days ago, as well as mathematics in general. I understand that there are no right or wrong answers to the questions and that I should try to answer the questions to the best of my ability. The person giving the questionnaire will read the questions and I will answer each question as they are read to me. I understand that my name will not be on the questionnaire, so no one will know that the questionnaire is mine.

□ Yes, I agree to participate in the study. I will complete the questionnaire.

Signature ______________________________________

□ No, I do not agree to participate in the study. I will not complete the questionnaire.

Signature ______________________________________

VITA AUCTORIS:

NAME: Melissa Rae Farrand

PLACE OF BIRTH: Windsor, Ontario

DATE OF BIRTH: October 18, 1972

EDUCATION:

SECONDARY SCHOOL:

St. Anne's High School, 1991, Tecumseh, Ontario

UNIVERSITY DEGREES:

Bachelor of Arts, University of Windsor, 1995

Bachelor of Education, University of Windsor, 1996